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EXPERIMENTAL STUDY ON HELICAL PILE IN CLAY

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Abstract: Helical Piles popularly used in the area of engineering applications providing stability against horizontal loads of tension, compression. Even the use of helical piles is increasing, the proper design and the outcome of helices parameter on the ultimate load is still under investigation. In this study, the behavior of helical piles under vertical loads in clayey soil examined through experimental research on model piles. Fixing various sizes of plates, some plates, and spacing of plates test conducted on rigid helical piles. Model helical piles made of 20mm diameter mild steel shafts to which mild steel plates of 100mm diameter welded. For comparison, a single straight cylinder with a diameter of 20mm was also tested. Test results revealed that the vertical capacity of the helical pile is higher than of straight shaft piles.

Index Terms - helical pile, different number of plate, different number of plate thickness, and different number of spacing.

I. INTRODUCTION

Pile foundations widely used in construction. When the top and bottom layers of soil are weak and strong relatively deep from the experimental results. Reinforced concrete piles most often used. An uneven settlement of building foundations will occur in weak soil, which creates the cracks in the structure deteriorations of the buildings; in such cases, helical piles are better alternatives. Helical piles made of steel deep foundation elements made up of a central steel shaft adding the number of helical bearing plates connected to this shaft. The shape is of helix plates circular. In this plated are the shaft to form into a narrow coil. When revolving into the soil, the helix shapes provide thrust along its longitudinal axis; thus, it proves to be helpful in pile installation. After the installation, the plates transfer the axial load into the soil through bearing. When the capacity of the shaft transfers the load to the soil, the counts of the helical plate limited. Helical piles have several advantages in comparison to another pile. They can be screwed easily to the ground, which is important in places where heavy technology operation is needed, such as in the basements under the bridges, etc. the installation of helical pile foundation causes practically no vibration. There is no problem during the installation near the existing foundation. These features of the helical pile which make the foundations attractive on environmentally sensitive sites. During loading, the load applied to the pile transferred to the surrounding soil. Thus the ultimate capacity of the pile is dependent upon the strength of the soil. Solis derive their strength and ultimate load-carrying capacity from several characteristics like the internal friction angle φ, the adhesion factor α, the unit weight γ, and the undrained shear strength of the soil.

II. SOIL PROPERTIES

S.No	PROPERTIES	RESULT	REMARKS
1	Initial moisture content	4%	-
1	Specific gravity	2.73	Inorganic clay
2	Particle size distribution % of gravel % of sand % of clay % of silt	 0% 28% 56% 16%	Clay
3	Atterberg's limits Liquid limit Plastic limit	 53% 28%	-
4	Plasticity index	25%	I_p > 17, high plastic
5	Soil classification	CH	-
6	Free Swell index	63%	DFS >50% degree of expansion is high
7	Optimum moisture content	22.4%	-
	Maximum dry density	1.65 g/cc	-
8	Unconfined Compressive strength	67 kN/m^2	-
	Cohesive Strength	33.5 kN/m^2	-

III.MODEL HELICAL PILE

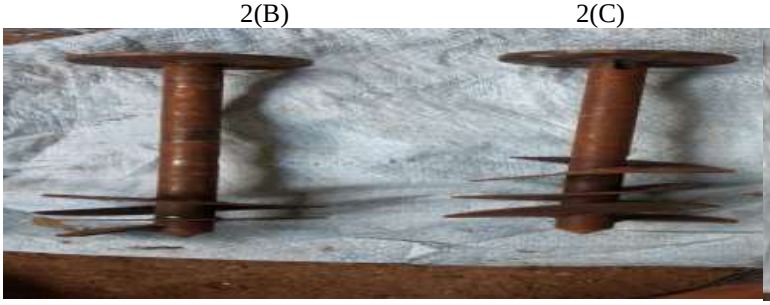
The usual model pile used in this study made up of mild steel, which has a diameter of 20mm and a total depth of 450mm.In a helical pile, there are four combinations. The all helical pile has a diameter of 20mm, 450mm length. The plate diameter is 100mm. And other specifications of four combinations of helical pile is given below.

Normal model pile

1(A)

1(B) 1(C)

2(B) 2(C) 2(A)



3(B) 3(C) 3(A)

4(A)

4(B) 4(C)

Model standard pile and combinations all of the helical piles

HELICAL PILE COMBINATION	NUMBER OF HELICAL	PITCH DISTANCE(mm)	THICKNESS OF THE PLATE(mm)
1(A)	1	30	2.5
(B)	2	30	2.5
(C)	3	30	2.5
2(A)	1	40	2.5
(B)	2	40	2.5
(C)	3	40	2.5
3(A)	1	30	4
(B)	2	30	4
(C)	3	30	4
4(A)	1	40	4
(B)	2	40	4
(C)	3	40	4

Combinations of all helical piles

MODEL TEST TANK

The dimensions of the mode test tank are decided based on the active stress zone of soil mass from the edge of the foundation. The test tank used for experimental investigations is a circular tank with a dimension of 500mm diameter and depth of 500mm. Dimensions of the model tank fixed in such a way that the failure surface does not interact with the caisson. The model tank is made in mild steel material and fabricated as a watertight tank.

PREPARATION OF CLAY BED

In cohesive soil, the experimental tests carried out in high compressibility of soil. The bed of the clay sample is making in the tank by the initial moisture content is 13.80%. The tank filled the clay sample is 22 layers and 100 blows by finding the energy calculations.

IV.EXPERIMENTAL SETUP

The load frame consists of a proving ring of 5kN capacity and a 50kN load cell for load determination and 2 LVDT (Linear Variable Displacement Transducers) for settlement prediction. Figure5.2.shows the experimental setup for vertical loading.

Experimental setup for vertical loading

TEST PROCEDURE

The vertical load test conducted on the typical model pile and helical pile in clay with a high compressibility clay and the ultimate vertical capacity of the helical pile found out.

PROCEDURE FOR AXIAL LOAD TEST

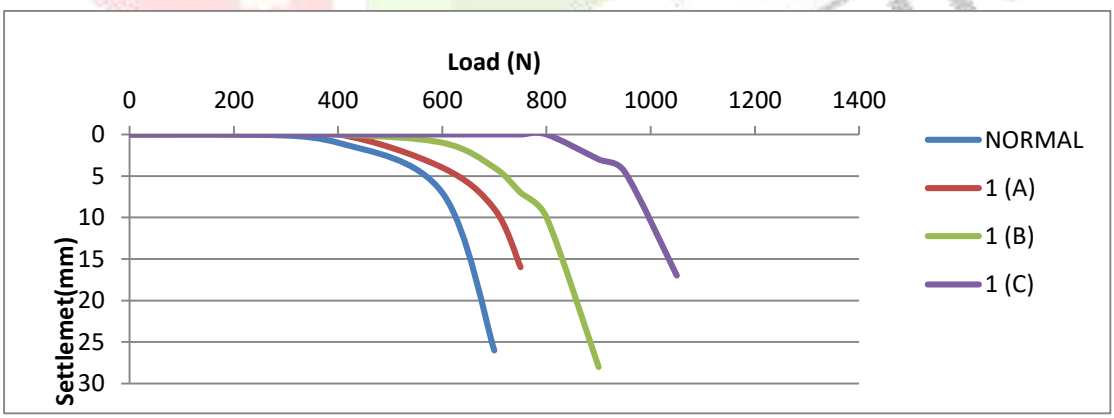
The axial load test conducted on the typical model pile and helical pile as per the following procedure recommended by IS 2911 (part 4) – 1985.

- The proving ring and two LVDTs placed in position over the pile cap,
- Axial load is applied in increments using 50kN, proving ring over the pile cap. Each increase of loading maintained until the pile settlement value become less than 0.02mm/min
- The vertical deflection of the pile is measured by LVDT corresponding to the load, which is measured using the proving ring when the deviation of the pile ceases. The next load increment applied.
- The test proceeds until the pile achieves its ultimate axial capacity for the corresponding failure load.

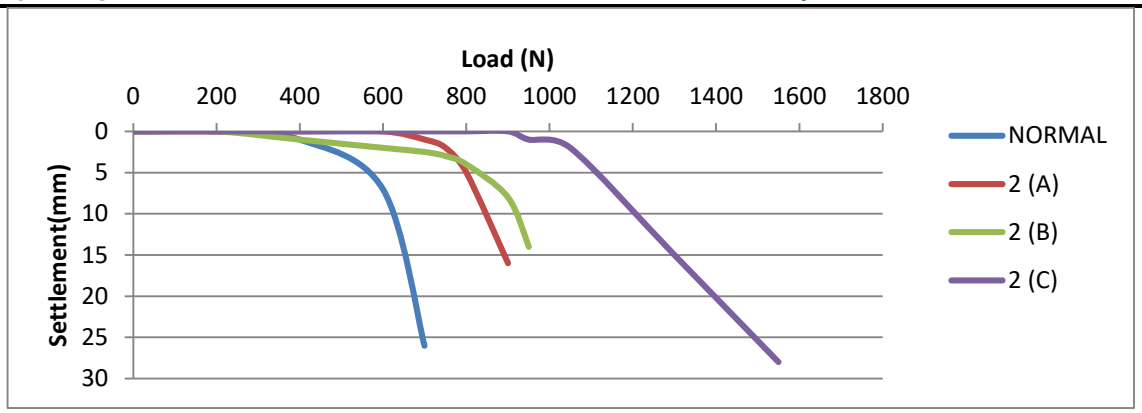
V. RESULTS AND DISCUSSION

The safe vertical load on the pile as per IS 2911-1985 shall be taken as the least of the following:

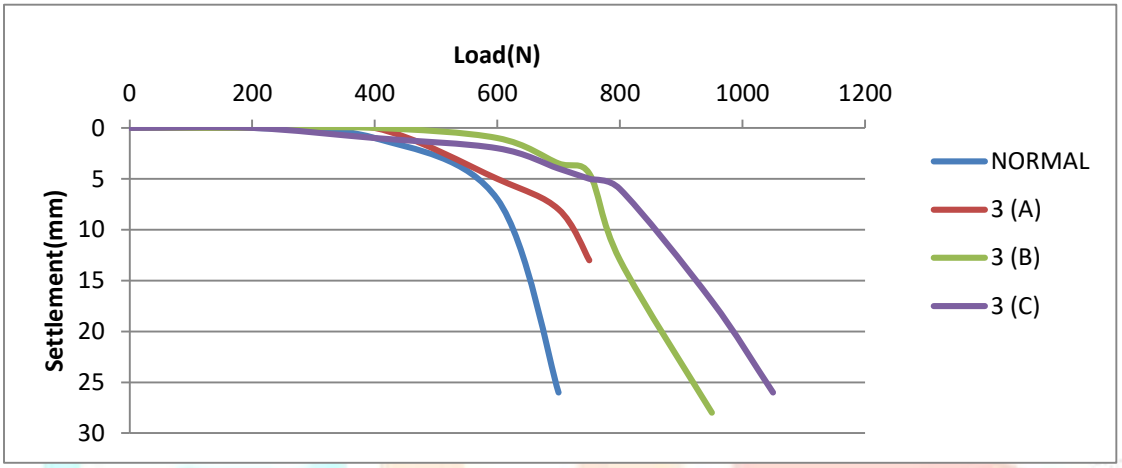
- One-half of the final load, which causes settlement equal to 10% of the pile diameter.
- Two-thirds of the final load which cause a total settlement of 12mm
- Two-thirds of the last load which generate a net settlement of 6mm



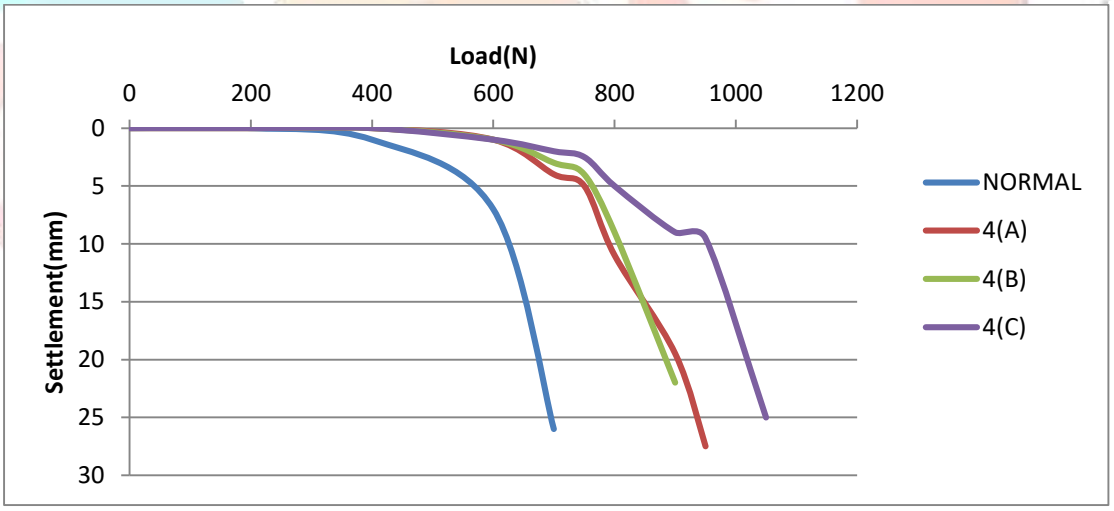
The load-settlement curve for helical pile 1[(A)(B)(C)]-Normal pile



The load-settlement curve for helical pile 2 [(A)(B)(C)]-Normal pile



The load-settlement curve for helical pile 3[(A)(B)(C)]-Normal pile



The load-settlement curve for helical pile 4[(A)(B)(C)]-Normal pile

SAFE VERTICAL LOAD

Pitch distance(mm)	The thickness of the plate(mm)	Safe vertical load (N)		
		Number of plates		
		1	2	3
30	2.5	631	722	820
40	2.5	717	731	913
30	4.0	771	863	1173
40	4.0	793	969	1198
Normal pile		596		

DISCUSSIONS

INFLUENCE OF PITCH DISTANCE IN HELICAL PILE CAPACITY

The vertical load-carrying capacity of the helical pile increases is with the rise in pitch distance.

INFLUENCE OF NUMBER OF PLATES IN HELICAL PILE CAPACITY

The vertical load-carrying capacity of the helical pile increases is with the rise in the number of plates.

INFLUENCE OF THICKNESS OF PLATES IN HELICAL PILE CAPACITY

The vertical load-carrying capacity of the helical pile increases is with the increase in the thickness of plates.

VI.CONCLUSIONS

The present work was undertaken to investigate the increase of load-carrying capacity and reduction of settlement in clay soil by using a helical pile. For this purpose, the laboratory model set up and loading tests conducted on a small scale model of helical pile resting on clayey soil. The following conclusions were from the experimental results made.

- The maximum vertical load-carrying capacity of 1198N is obtained at a 40 mm pitch distance using 3 number of 4mm helical plates.
- The ultimate load-carrying capacity of helical pile increases as the plate thickness, pitch distance, and some plate increases.
- The ultimate load-carrying capacity of the helical pile in vertical load condition found to be increased by two times compared to that of the usual pile
- The settlement of the helical pile can also considerably reduced by 2 to 3 times of usual pile.

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